DESIGN OF A PROJECTION-BASED PARALLEL DELAUNAY MESH GENERATION AND REFINEMENT ALGORITHM

Clemens Kadow[a] and **Noel Walkington**[b]

[a]Mechanics, Algorithms, and Computing Laboratory
Department of Civil and Environmental Engineering and
Department of Mathematical Sciences
Carnegie Mellon University
Pittsburgh, PA 15213-3890
kadow@cmu.edu

[b]Department of Mathematical Sciences
Carnegie Mellon University
Pittsburgh, PA 15213-3890
noelw@cmu.edu

Triangular and tetrahedral meshes of guaranteed good quality are an important ingredient of many simulations in Computational Science and Engineering. In particular, large-scale computations that deal with complex geometries or that require frequent remeshing call for efficient robust parallel mesh generation algorithms. Delaunay refinement has been proven capable of generating high-quality meshes for arbitrary domains [1,2]. However, Delaunay mesh generation and refinement algorithms are unstructured and sequential in nature, and thus difficult to parallelize.

We present a fully parallel end-to-end algorithm to solve the meshing problem for coarse-grain distributed memory computers. Our algorithm is an extension to the efficient parallel Delaunay triangulation algorithm by Blelloch et. al. [3] generating conforming Delaunay meshes that respect given quality constraints. Recent theoretical considerations [4] support our algorithmic design.

We use a powerful projection idea based upon the equivalence of Delaunay tesselation and convex hull in an augmented space. This enables us to partition the final mesh along edges/faces by the location of element centerpoints prior to generating elements. Once the input is partitioned, we can generate a tesselation asynchronously across the parallel machine. During refinement, most point insertion will be local, requiring no communication. For points close to processor boundaries we update the partition, maintaining certain induction hypothesis for the current pointset. Exploiting properties of Delaunay meshes, the partition can be updated asynchronously on different processors. Our protocol is carefully designed to minimize communication, avoid blocking, and yet provably generate the correct refined Delaunay mesh.

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References

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